

Special reference is made to case confirmation studies on Rocky Mountain spotted fever and endemic typhus in Georgia and to effective tick control measures. McDuffie and Smith discuss tick control in further detail on p. 327.

The Status of Rocky Mountain Spotted Fever in the Southeastern United States

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ROCKY MOUNTAIN spotted fever is unique among the arthropod-borne diseases of man now or formerly endemic in the southeastern United States in that no reservoir host other than the tick vector appears to be required. Transovarian transmission occurs, and larvae, nymphs, and adults are all potentially capable of transmitting the infection. Presumably even the egg might infect if it were crushed on the unprotected skin. Nevertheless, extensive research on rickettsial spotted fever over many years has revealed no naturally infected animal in the United States. When the disease is experimentally transmitted to dogs and other mammals, the infection is frequently silent, and the only indication of inoculation is the develop-

ment of Weil-Felix and complement-fixing antibodies (1).

As is well known, the number of infected ticks in nature is subject to great variation but seldom has been found, even in highly endemic areas, to exceed 3 percent (1). Under ordinary circumstances the infection rate is usually of the order of one in many thousands.

In 1902 Wilson and Chowning (2) suggested that Rocky Mountain spotted fever was tick-borne and that the etiological agent was a protozoan. Subsequently Ricketts (3), Parker and his associates in the Rocky Mountain Laboratory of the Public Health Service at Hamilton, Mont., and many others worked out the etiology and epidemiology of the disease and many of the details of tick-host relationships. Man is merely an unusually susceptible bystander, who by occasional accident intrudes himself into the cycle as a very unsatisfactory host for *Dermacentor andersoni* in the western or for *Dermacentor variabilis* in the eastern United States.

Rocky Mountain spotted fever was first identified in the eastern United States in 1931 by Badger, Dyer, and Rumreich (4). Until 1940 it was believed that the eastern strains were less virulent than the Bitterroot Valley strains,

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but in that year Topping and Dyer (5) reported the isolation of a strain, the W strain, from the Potomac Valley, which was in every way similar to the so-called Bitterroot strain. In 1941, in a note on the epidemiology of Rocky Mountain spotted fever, Topping (6) compared the existing data with regard to age and sex-specific morbidity and mortality from Montana and Idaho with that from Virginia and Maryland. Although he noted some interesting differences in attack rates, he showed that age-specific fatality was essentially the same in the east and the west. He also pointed out that *D. andersoni*, a parasite of large wild animals, occurs in greatest numbers at a distance from human habitation in sparsely settled areas while *D. variabilis* is sufficiently adapted to the dog to justify being named the American dog tick. This difference serves to explain the higher incidence of Rocky Mountain spotted fever among children in the east and among adult men who work in tick territory in the west.

Harrell (1) has assembled more recent and extensive data, shown in table 1, which is confirmatory of Topping's thesis. It will be noted that the fatality rates shown are almost identical for the east and the west. During the same period, 1939-46, Georgia had a fatality rate of 18.9 percent.

Comparison With Endemic Typhus

In introducing a comparison between Rocky Mountain spotted fever and endemic typhus, it is interesting to note that when the latter disease was first described in the United States, in 1913, by the late Dr. James E. Paullin (7) of Atlanta, existing epidemiological knowledge did not enable him to differentiate between the infection he described and Brill's disease, the separate etiology of which was first suggested by Zinnser (8) in 1934 and finally clarified by Murray and his associates (9, 10), in 1950 and 1951 as a result of post-World War II developments.

In contrast to Rocky Mountain spotted fever, endemic typhus, we now know, is well established in an abundant mammalian host, the domestic rat, which serves as the reservoir from which the infection is transmitted to man. The principal vector is *Xenopsylla cheopis*, the In-

Table 1. Rocky Mountain spotted fever cases and deaths—selected western and southeastern States, 1939-46¹

State	Cases	Deaths	Percent mortality
<i>West</i>			
Wyoming.....	317	58	18.3
Montana.....	260	63	24.2
Colorado.....	106	26	24.5
Total.....	683	147	21.5
<i>Southeast</i>			
Virginia.....	504	92	18.3
Maryland.....	458	86	18.8
North Carolina.....	346	96	27.7
Total.....	1,308	274	20.9
United States total.....	4,033	929	23.0

¹ See reference 1.

dian rat flea. Control efforts, which have been reasonably successful, consist first, of DDT dusting of rat harborages for the purpose of preventing the spread of infection from rat to rat and from rat to man and, second, of rat control measures (11).

A summary of more recent reporting of Rocky Mountain spotted fever in 10 southeastern States, as compared with typhus, is given in table 2. Certain of the data are of particular interest.

First, it will be noted that the southeast has accounted for about one-half of the reported cases of Rocky Mountain spotted fever in the United States during the 1949-53 period.

Second, these data show that typhus in the southeast has reportedly declined from two-thirds of the national total in 1949 to less than one-half the United States total in 1953.

Third, since 1952, more Rocky Mountain spotted fever than typhus has been reported.

Fourth, it appears that the States of the upper south—Virginia, Kentucky, Tennessee, and North Carolina—have a marked predominance of Rocky Mountain spotted fever over typhus and that typhus leads in the Gulf States and Georgia, while South Carolina is approaching a balance between the two diseases. The fatality rate for Rocky Mountain spotted fever in

Georgia during the total period 1939-53 was 18.1 percent, while the typhus fatality rate was 4.9 percent.

Case Confirmation Studies

Laboratory confirmation of reported Rocky Mountain spotted fever was undertaken in 1939 by the Georgia Department of Public Health in order to determine the true incidence of this disease in Georgia and has been continued to the present time. Confirmation was based on animal protection tests during the early part of the period covered by table 3 and upon complement fixation tests during recent years (see footnote 2, table 3). From the first, these studies have necessarily included cases of endemic typhus because of the similarity in etiology and clinical behavior of the two diseases. Moreover, the Weil-Felix reaction is common to both and not infrequently a case diagnosed as typhus on the basis of a positive Weil-Felix test has been shown to be Rocky Mountain spotted fever. On the other hand, all typhus confirmations recorded from Georgia prior to 1945 were obtained on patients suspected of having Rocky Mountain spotted fever.

A parallel typhus case investigation program came into existence as a result of the reduction in funds available for typhus control. For

planning purposes, it became essential to know whether reported typhus cases gave a true picture of the incidence of this disease.

It will be noted from table 3 that although typhus showed a steady decline after 1945, the incidence of Rocky Mountain spotted fever continued at a comparatively high level through 1949. Much of the decrease in typhus was undoubtedly the result of the DDT and rat control programs (11), and since 1946 the incidence of Rocky Mountain spotted fever has been influenced by the eradication of several suburban foci around Atlanta (15). After about 1949 or 1950, however, the decline in the reported incidence of the two diseases has been affected by the availability of drugs effective in the treatment of rickettsial infections.

The antibiotics—terramycin, aureomycin, and chloramphenicol—produce a marked effect on the clinical course of the two infections. Studies in Georgia and elsewhere also show that these drugs influence the appearance of Weil-Felix and complement-fixing antibodies (14, 16). It is probably safe to say that a relatively small percentage of Rocky Mountain spotted fever and typhus infections now develop to the point of complete diagnosis and reporting.

The notation used in table 4 has no mathematical basis. It is an attempt to show together the Weil-Felix (left) and complement fixation titers (right) on individual specimens. As

Table 2. Reported cases of Rocky Mountain spotted fever and endemic typhus for the United States and southeastern States, 1949-53

State	Rocky Mountain spotted fever					Typhus				
	1953	1952	1951	1950	1949	1953	1952	1951	1950	1949
United States total.....	301	327	347	464	570	230	205	378	685	985
Southeastern States.....	145	158	170	226	284	110	108	190	445	649
Georgia.....	14	8	8	13	28	41	27	58	162	214
Alabama.....	7	2	3	15	11	21	11	12	130	142
Tennessee.....	10	15	17	23	33	7	3	15	12	28
North Carolina.....	38	38	61	70	79	0	12	19	12	26
South Carolina.....	9	6	5	12	8	11	10	22	15	22
Mississippi.....	(¹)	6	6	5	3	11	25	16	13	12
Louisiana.....	1	0	1	4	1	7	8	22	62	76
Florida.....	0	2	2	0	0	11	11	20	34	123
Virginia.....	60	79	63	77	101	0	0	3	4	3
Kentucky.....	7	2	4	7	20	1	1	3	1	3

¹ No report.

Table 3. Rocky Mountain spotted fever and typhus fever investigations in Georgia, 1939-53¹

Year	Rocky Mountain spotted fever			Typhus fever		
	Reported cases	Confirmed cases	Deaths	Reported cases	Confirmed cases	Deaths
1953.....	14	9	2	41	13	2
1952.....	8	0	1	32	17	4
1951.....	8	1	3	58	7	5
1950.....	13	8	1	162	51	4
1949.....	28	14	2	214	41	14
1948.....	32	16	8	218	72	18
1947.....	23	18	5	441	145	31
1946.....	34	27	4	606	213	33
1945.....	21	18	5	1, 111	18	59
1944.....	12	11	4	1, 182	² 1	63
1943.....	8	6	3	1, 256	² 4	57
1942.....	8	1	2	1, 153	(²)	52
1941.....	6	0	1	944	(²)	36
1940.....	15	12	2	589	(²)	26
1939.....	7	6	0	1, 131	(²)	44

¹ Includes only cases reported through usual channels to the Georgia Department of Public Health. Does not include 210 typhus cases picked up in epidemiological investigations made by Hill and associates (12, 13) and by Stewart and Hines (14) in Brooks, Grady, Thomas, and Decatur Counties, Ga., during the period January 1945-January 1953.

² Data for 1939-46 are based upon case histories and laboratory confirmations obtained by Dr. T. F. Sellers, then director of laboratories, Georgia Department of Public Health (now, director of the department). Typhus cases confirmed during this period were only in those patients suspected of having Rocky Mountain spotted fever. In 1939-40, confirmation was by animal protection tests carried on by the Typhus Research Unit of the Public Health Service at Albany, Ga. From 1942 to 1946, confirmations were based on complement fixation tests performed at the National Institutes of Health. From 1946 to date, complement fixation tests have been carried on in the Chamblee, Ga., and Montgomery, Ala., laboratories of the Communicable Disease Center, Public Health Service.

will be noted, the development of Weil-Felix antibodies is somewhat delayed under the impact of antibiotic therapy while complement-fixing antibodies may not appear for months, and the final titer may be considerably reduced below the levels formerly obtained. The exact interval of delay cannot be stated since specimens were not obtained with this purpose in view. Terramycin, aureomycin, and chloramphenicol appear to manifest an effect in the order named. Penicillin has no effect on either Weil-Felix or complement fixation titers and no effect on the course of the illness.

Five of the nine cases of Rocky Mountain spotted fever confirmed in 1953 were originally reported as typhus. One of the confirmed typhus cases was reported as Rocky Mountain spotted fever. Five of the 29 unconfirmed typhus cases were classified as presumptive, but 24 of these cases remained diagnostic problems even after prolonged study.

Various possibilities suggest themselves with regard to these cases, but it should be recalled that in Georgia almost all "reported" Rocky

Mountain spotted fever and typhus are picked up by query as the result of positive Weil-Felix examinations done in health department laboratories. The difficulty is therefore apparently serologic, arising from the suppression of rickettsial infections by antibiotics referred to previously.

Fortunately, followup specimens can be obtained on the majority of Weil-Felix positive cases, and on cases on which complement fixation tests have been requested if the surveillant agency is prepared to assist, either directly or through local health departments, in obtaining specimens. It is also necessary in requesting specimens to persevere to the point at which persistence ceases to be a virtue.

The problem of obtaining convalescent and postconvalescent specimens is difficult indeed when the initial Weil-Felix reaction is negative. Although the case may be diagnosed as spotted fever or endemic typhus, second specimens are seldom forwarded unless the patient continues to be ill after treatment with broad spectrum antibiotics. This leaves the laboratory in a

quandary since it appears impractical to catalog and hold negative serums on suspected cases indefinitely on the assumption that a later specimen may show a rise in titer. Negative specimens are now retained for approximately 1 month in the laboratories of the Georgia Department of Public Health.

Tick Control Methods

During recent years the possibility of using certain compounds as tick repellants has been investigated by several workers. These compounds have been applied as dusts and aerosols to skin and clothing and as solutions or emulsions to clothing.

Despite statements in the literature which imply otherwise, roadside and pathside control of *D. variabilis* and, in our experience, of *Amblyomma americanum* is so easily obtained with insecticides that chemical control has very definite application in inhabited areas of high Rocky Mountain spotted fever hazard or even where tick annoyance is the only problem. Dust, sprays, mists, and possibly even fogs, with several of the older insecticides are reasonably effective. It is conceivable that some of the newer insecticides, for example dieldrin (17), would be even more useful, but we have had little occasion to try them in Georgia.

Interest in the control of Rocky Mountain spotted fever in Georgia reached a high point in 1945 following the occurrence of 24 clinical cases, 17 of which were serologically confirmed, in the semiurban regions of De Kalb and Fulton Counties (Atlanta) during the period 1939-45. In 1946, when work was begun in the Alexander Estates section of De Kalb County, the most seriously affected area, the entire section was beginning to drop in the economic scale despite its being conveniently located, already subdivided, and having city conveniences available. When no Rocky Mountain spotted fever cases occurred during the next 2 years, the situation changed completely. By 1951 homes had been erected on every lot available for construction, and a shopping center had developed in the area.

The following insecticides have been used successfully in tick control:

DDT, at the rate of 2.5 lb. of actual insecticide per acre for dusts, sprays, mists, and fogs. If rosin-DDT emulsion is used in a good mist machine, 1.5 lb. of DDT per acre gives good residual control of *D. variabilis* for an entire tick season. No burning of vegetation was noted when rosin emulsion was applied along roadsides.

Chlordane, at 1 lb. per acre, is almost as effective as DDT in dusts, sprays, mists, and fogs.

Table 4. Weil-Felix/complement fixation results in 12 patients diagnosed as having Rocky Mountain spotted fever and treated with antibiotics, 1953-54

Patient	Blood specimen			Time onset to last blood specimen	Drug
	1st	2d	3d		
1-----	640/N	N/N	-----	Months 2	Terramycin.
2-----	-----	N/8	-----	7	Do.
3-----	1280/N	320/N	N/16	6	Do.
4-----	320/N	-/N	320/8	2	Aureomycin.
5-----	N/-	80/64	-----	2	Do.
6-----	320/N	N/-	N/32	6	Do.
7-----	640/N	640/8	-----	2	Do.
8-----	80/N	80/16	-----	6	Chloramphenicol.
9-----	1280/N	1280/N	-----	Days 18	Do.
10-----	N/N	N/N	N/N	9	Do.
11-----	640/N	2560/N	60/64	Months 2	{Terramycin. Chloramphenicol. Penicillin.
12-----	-----	N/256	-----	6	

NOTE: Dash (—) means test not done or results unknown, and N means negative.

Benzene hexachloride, at one-half pound per acre, was inferior to DDT and chlordane. It gave best results when applied as a mist.

Methoxychlor, at 2.5 lb. per acre, gave good immediate control but broke in less than 1 month.

Smith, Cole, and Gouck (18) pointed out in their classic study on the American dog tick that this tick (*D. variabilis*) tends to collect along roadsides and paths. This fact has occasioned the interest of Knutson (19) and others in the use of very narrow dust or spray barriers along roadsides. Glasgow and Collins (20) report use of DDT dust at a rate of 1 lb. per acre in a 4-foot wide strip. Knutson used a low pressure, low gallonage sprayer to apply 4 lb. of DDT per acre in a strip 6-8 feet wide. In a single narrow barrier dust experiment repeated by us, very good results were obtained.

Nevertheless, these methods afford protection only to persons or animals who stay in the road and do not venture across the barrier. Children and dogs have a tendency to go to the ticks even though the ticks cannot come to them. For this reason, and also because power equipment, particularly mist generators, will give excellent coverage of a 50- to 100-foot strip along roadways, a wider swath has been used by us. Results have been equal to those described in narrow barrier experiments, the immediate knockdown is more extensive, and the residual effect is probably as great although no one has had an opportunity to make a comparative study. In addition, McDuffie and associates (21) have reported data which imply that reinfestation tends to occur more slowly when the treated area is large.

Wide-strip spraying is an easier technique in use since one can "offset" the line to be treated and operate from the roadway. Narrow barrier application with power equipment runs afoul of telephone poles, trees, benches, signs, and other obstacles. In wide-strip application it is convenient to apply insecticide in two runs, with the spray or dust aperture pointed at the road edge on one trip and set for maximum distance on the second.

Summary

Rocky Mountain spotted fever is a disease of measurable though not great public health im-

portance in the southeastern United States. It ranks with or exceeds endemic typhus as a cause of morbidity and mortality in all the States of the area (Alabama, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia).

Reporting of all rickettsial infections has been adversely affected by the availability of effective chemotherapeutic agents. The rickettsial infections are so well masked by antibiotics that many cases are aborted and diagnosis with complete laboratory confirmation is a rarity. Development of complement-fixing antibodies is delayed sometimes for 6 or more months. Confirmation of diagnosis in recent years has been achieved largely as the result of epidemiological followup of cases by public health agencies.

Tick repellants have been developed to a point which makes their use practical by persons working or playing in infested areas. Chemical control of ticks in thickly settled Rocky Mountain spotted fever foci has been satisfactorily achieved. Barrier spraying along roadsides is sufficiently simple and effective to merit consideration wherever ticks annoy enough people to make tick control economically acceptable.

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Blind Vending Stand Operators

Nearly 1,670 blind vending stand operators and their employees earned approximately \$4.8 million during fiscal year 1954, the United States Office of Vocational Rehabilitation in the Department of Health, Education, and Welfare reported in January. These are the highest net earnings ever recorded by the blind men and women who operate vending stands under the Randolph-Sheppard and State laws.

In fiscal year 1953 net earnings for these businesses were approximately \$4.5 million.

This year's record was made by the blind operators with the aid of 272 blind and 629 sighted employees. The blind operators averaged \$2,200 each. Virtually all blind persons in the vending stand program were prepared and trained by their State vocational rehabilitation agencies.

Nearly 1,600 stands are currently operated under the Randolph-Sheppard Act, 573 of these being on Federal sites. Under recent amendments to the act, vending stands can be established on all types of suitable Federal property—in national parks, for instance. In the past this authority has applied only to federally owned or leased buildings. The Federal law has always required that preference be given to qualified blind persons as operators of stands on Federal property.

It is estimated that there are 308,000 blind persons in the United States today. Of this number, only about 8 percent are employed in all types of occupations. Experience in the rehabilitation of disabled individuals has indicated that about 25 percent of those disabled by blindness can be rehabilitated into gainful employment.

For Heart Research

BETHESDA, Md. Although the inflated cuff method of taking an indirect blood pressure reading is satisfactory for most diagnostic purposes, it is frequently necessary in cardiovascular research to obtain a very precise pressure measurement directly within the blood vessel.

This can now be done with the dependable, inexpensive, easily portable apparatus for making such blood pressure records, which has been recently developed by the Public Health Service at the Laboratory of Technical Development, National Heart Institute. The instrument was designed by Frank W. Noble,

Dr. James J. Callaway, and Dr. Bert R. Boone, chief of the laboratory.

The instrument consists of a simple electrical circuit, housed in a small metal box called a control box, which can be made for a few dollars by following easy instructions. This control box and its circuit provide the proper link between a standard physiological strain gauge and a direct-writing electrocardiograph. When attached to a conventional electrocardiograph, the instrument produces accurate pressure recordings formerly available only by the use of costly and complex instruments.

Pressure in the blood vessel is measured by the strain gauge and is translated into electrical forms acceptable to the electrocardiograph by the control box. The control apparatus houses a circuit which enables the investigators to insert a zero pressure reference point into the rec-

ord at will. The pressure records thus obtained are of good accuracy and provide measurements of pulse contours, and of mean, systolic, and diastolic pressures. The device is expected to provide savings to those physicians and clinicians not having access to expensive pressure recording apparatus.

The operation of the instrument is illustrated in the photograph. Pressure signals obtained from a needle placed in a blood vessel of the arm are picked up by the strain gauge (left) and pass through the control box (right) to the electrocardiograph (center) where they are recorded on standard electrocardiograph paper.

Detailed information may be obtained from Dr. Bert R. Boone, Chief, Laboratory of Technical Development, National Heart Institute, National Institutes of Health, Public Health Service, Bethesda 14, Md.

